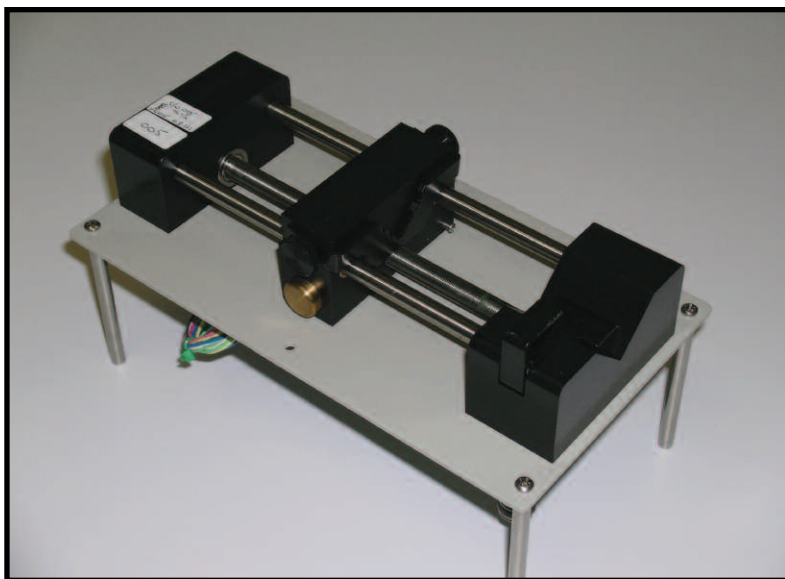


Caribou OEM Syringe Pump Component User's Manual

MA1 98-2482



HARVARD
A P P A R A T U S

Publication 5416-001-REV-A

WEEE/RoHS Compliance Statement

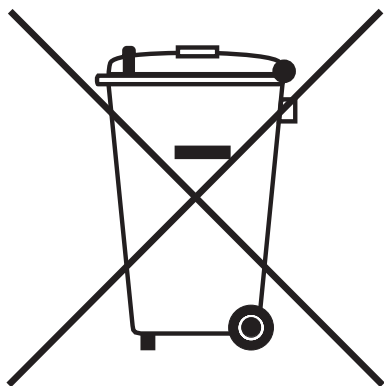
EU Directives WEEE and RoHS

To Our Valued Customers:

We are committed to being a good corporate citizen. As part of that commitment, we strive to maintain an environmentally conscious manufacturing operation. The European Union (EU) has enacted two Directives, the first on product recycling (Waste Electrical and Electronic Equipment, WEEE) and the second limiting the use of certain substances (Restriction on the use of Hazardous Substances, RoHS). Over time, these Directives will be implemented in the national laws of each EU Member State.

Once the final national regulations have been put into place, recycling will be offered for our products which are within the scope of the WEEE Directive. Products falling under the scope of the WEEE Directive available for sale after August 13, 2005 will be identified with a "wheelie bin" symbol.

Two Categories of products covered by the WEEE Directive are currently exempt from the RoHS Directive - Category 8, medical devices (with the exception of implanted or infected products) and Category 9, monitoring and control instruments. Most of our products fall into either Category 8 or 9 and are currently exempt from the RoHS Directive. We will continue to monitor the application of the RoHS Directive to its products and will comply with any changes as they apply.



- **Do Not Dispose Product with Municipal Waste**
 - **Special Collection/Disposal Required**

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General Information

Serial Number

All inquiries concerning our product should refer to the serial number of the unit. Serial numbers are located on the underside of the mounting plate.

Calibration

All syringe pumps are designed and manufactured to meet their performance specifications at all rated voltages and frequencies.

Warranty

Harvard Apparatus warrants this instrument for a period of two years from date of purchase. At its option, Harvard Apparatus will repair or replace the unit if it is found to be defective as to workmanship or material.

This warranty does not extend to damage resulting from misuse, neglect or abuse, normal wear and tear, or accident.

This warranty extends only to the original customer purchaser.

IN NO EVENT SHALL HARVARD APPARATUS BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES. Some states do not allow exclusion or limitation of incidental or consequential damages so the above limitation or exclusion may not apply to you. **THERE ARE NO IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR USE, OR OF ANY OTHER NATURE.** Some states do not allow this limitation on an implied warranty, so the above limitation may not apply to you.

If a defect arises within the two-year warranty period, promptly contact **Harvard Apparatus, 84 October Hill Road, Holliston, Massachusetts 01746-1388** using our toll free number 1-800-272-2775. Outside the U.S. call 508-893-8999. Goods will not be accepted for return unless an RMA (returned materials authorization) number has been issued by our customer service department. The customer is responsible for shipping charges. Please allow a reasonable period of time for completion of repairs, replacement and return. If the unit is replaced, the replacement unit is covered only for the remainder of the original warranty period dating from the purchase of the original device.

This warranty gives you specific rights, and you may also have other rights which vary from state to state.

Repair Facilities and Parts

Harvard Apparatus stocks replacement and repair parts. When ordering, please describe parts as completely as possible, preferably using our part numbers. If practical, enclose a sample or drawing. We offer a complete reconditioning service.

CAUTION:

This pump is not registered with the FDA and is not for clinical use on human or veterinary patients. It is intended for research use only.

CAUTION
FOR RESEARCH USE ONLY
NOT FOR CLINICAL
USE ON PATIENTS

General Safety Summary

Please read the following safety precautions to ensure proper use of your modular syringe pump. To avoid potential hazards and product damage, use this product only as instructed in this manual. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

To Prevent Hazard or Injury:

Use Appropriate Power Supply

Use only an approved power supply. Be sure to observe proper polarity of connections when hooking up DC supply voltage.

CAUTION: FAILURE TO MAINTAIN POLARITY MAY RESULT IN DAMAGE TO THE UNIT AND WILL VOID THE WARRANTY.

Vdc positive—PIN 5 of 9 Pin D-Sub (P1)

Vdc return—PIN 9 of 9 Pin D-Sub (P1)

(see input connections diagram)

Ground the Product

This product is grounded through a ground stud located on the under side of the base plate. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making any connections to the input or output terminals of the product, ensure that the product is properly grounded.

Make Proper Connections

Make sure all connections are made properly and securely. Any signal wire connections to the unit must be no longer than 3 meters.

Orient Equipment Properly

Do not position the equipment such that it is difficult to reach the disconnecting device.

Observe All Terminal Ratings

Review the operating manual to learn the ratings on all connections.

Avoid Exposed Circuitry

Do not touch any electronic circuitry inside of the product.

Do Not Operate with Suspected Failures

If damage is suspected on or to the product do not operate the product. Contact qualified service personnel to perform inspection.

Avoid Pinch Hazards

Pinch hazards may exist between the pusher block and the end block and at the belt/pulley. Avoid placing fingers between these points while the pump is running.

Procedures which could result in injury shall only be carried out by operators who have been warned of the potential hazards and have received adequate training in carrying out the procedures in the safest possible manner.

General Safety Summary (cont'd)

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Place Product in Proper Environment

Environmental Conditions:

- Indoor use only
- Temperature 5°C to 40°C (40°F to 104°F)
- Humidity 20% to 80% RH
- Well Ventilated Room
- Altitude up to 2000 m
- DC Voltage Fluctuation not to Exceed +/- 5% of Nominal
- Transient Overvoltage Category II
- Pump is Rated Pollution Degree I

Observe all Warning Labels on Product

Read all labels on product to ensure proper usage.



CAUTION
Refer to Manual



Caution:
Pinch
Hazard



Caution:
Pinch
Hazard

The new Caribou OEM Syringe Pump Component is designed as a highly precise, single-syringe infusion pump module capable of moderate to high back pressures. The module includes a mechanism, hardware and software and requires the addition of a power supply and user interface.

Typically, the Caribou OEM Syringe Pump Component holds one syringe of any make, from 0.5 μ l to 60ml. The diameter of the syringe is entered via your PC or other controller, and the internal microprocessor drives a precision stepper motor to produce accurate fluid flow. This unit is designed to operate inside an appropriately rated fire/electrical/mechanical enclosure or cabinet.

Features:

Two Modes of Operation:

Constant Flow Rate and Volume Dispense

The Caribou OEM Syringe Pump Component will operate continuously in RATE mode, or accurately dispense a specific amount of fluid in VOLUME mode. When starting the pump, RATE mode will be the default mode. To operate in Volume mode, set a target volume and the pump will change modes to suit desired operation.

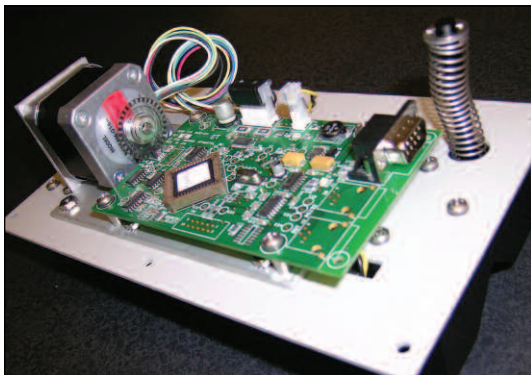
Infuse Limit Switch:

An infuse limit switch is located on the syringe block and an adjustable actuator is located on the pusher block. When the actuator contacts the limit switch, infusing is stopped. Adjust the actuator appropriately such that the syringe plunger does not bottom out in the syringe.

Introduction

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Input Connections



Packing List

- 1) Main Unit
- 2) Tube of lubricant
- 3) User's Manual

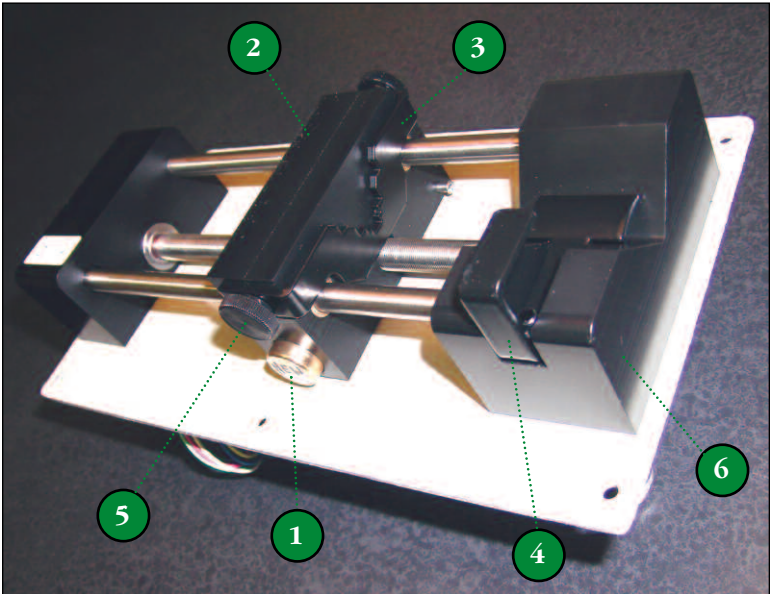
Installation

Location Requirements for the Syringe Pump

- A sturdy, level, clean and dry surface
- Minimum of one inch (2.5cm) clearance around the pump
- Appropriate environmental conditions
- Mount into an appropriately rated enclosure or cabinet

Loading the Syringe

1. Release the **syringe pusher** (2) by pressing the **bronze button** (1) on the side of the pusher.
2. While holding the bronze button 'in', slide the pusher to the left.
3. Raise the spring loaded **syringe retainer** (4) and swing it out of the way.
4. Lay the loaded syringe in the '**V**' shaped holder (6).
5. Swing the retainer so it holds the syringe in place.
6. Move the pusher so it makes contact with the syringe plunger.
7. Adjust pusher **block bracket** (3) and Syringe **retainer knobs** (5) to capture plunger and body of syringe.



Getting Started

Plug one end of the Power/RS232 cable into P1 connection on board. Connect the other end of the cable into your power supply and PC (not included). Refer to page 6 of this manual to reference the board connections.

Working with the Pump

The safest way to use the Caribou OEM Syringe Pump Component is in the volume dispense mode. The pump will automatically stop when target volume is dispensed.

Check Syringe Often

The Caribou OEM Syringe Pump Component will shut itself off when the syringe is empty or is otherwise overloaded. Although this presents no hazard to the user or the pump, it is prudent to check the syringe from time to time.

Maintenance

Keep the Caribou OEM Syringe Pump Component clean and dry. Avoid liquid spills that may find their way into the electronics.

A small tube of grease is provided for periodic lubrication of the lead screw. It is important to keep the leadscrew clean and lubricated.

To clean the exterior surfaces above the baseplate, use a lint-free cloth to remove loose dust. For more efficient cleaning, use a soft cloth dampened with water or an aqueous solution of 75% isopropyl alcohol.

If the pump does not work properly, contact Harvard Apparatus for appropriate instructions.

Protecting Small, Fragile Syringes

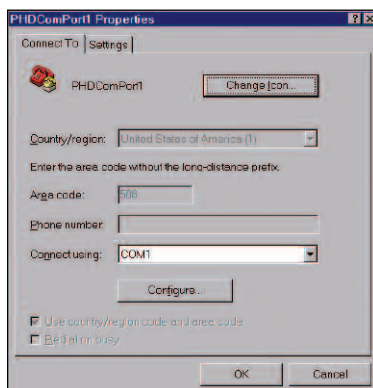
The Caribou OEM Syringe Pump Component will hold microliter size syringes down to 0.5 μ l size. These small syringes have fine wire plungers that may be damaged if allowed to bottom out. The Caribou OEM Syringe Pump Component is equipped with an adjustable limit switch actuator on the pusher block. Adjust the limit switch actuator position to prevent damage to small syringes.

Remote Control via the RS-232 Interface Using HYPERTERMINAL*

** Normally included with most Windows® operating systems.*

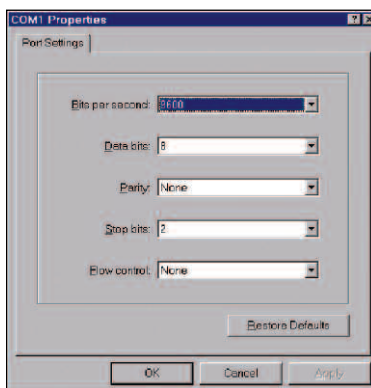
Caribou OEM Syringe Pump Component

1. Connect the Power/RS-232 cable between the Caribou OEM Syringe Pump Component RS-232 IN port and a PC's serial port.
2. On the PC (running a Microsoft Windows Operating System), select START – PROGRAMS – ACCESSORIES – HYPERTERMINAL – HYPERTERMINAL to start the Hyperterminal application. If Hyperterminal is not available, install it from the Microsoft Windows Operating System Install disks or CD ROM.
3. Set up the appropriate COMPORT for the following:



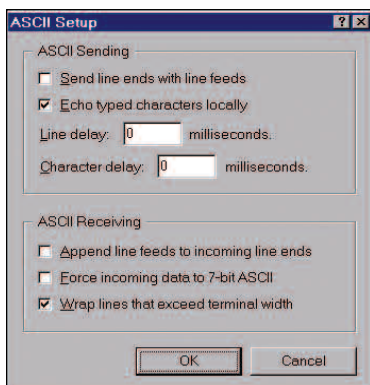
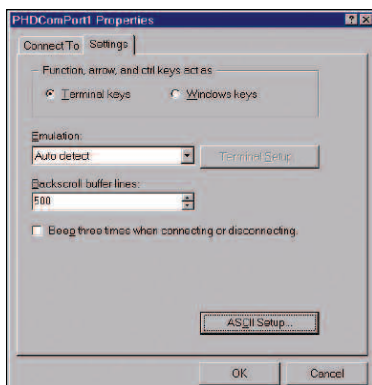
Configure:

Baud Rate : 9600
Data Bits: 8
Parity: None
Stop Bits: 2
Flow Cntrl: None
Emulation: Auto Detect



ASCII Setup:

Echo typed characters locally.
Line delay: 0
Character delay: 0
Wrap lines



You may want to save the setup information under a descriptive filename.

4. At the PC, launch hyperterminal with the above setup specifications (if it is not already running). Type VER at the PC keyboard and verify that the pump module's version is displayed at the PC terminal.
5. Type RUN to start the pump; type STP to stop the pump. After starting the pump, > should be displayed, indicating pump is infusing. After stopping the pump, : should be displayed.

Appendix A

Specifications:

| | |
|----------------------------|--|
| Accuracy: | ±0.35% |
| Reproducibility: | ±0.1% |
| Flow Performance: | <6% CV |
| Number of Syringes: | One |
| Syringe Sizes: | 0.5 µL (min), 50/60 mL B-D Plastic (max) |
| Flow Rate: | |
| Min.: | 0.001 µL/hr (with 0.5 µL syringe (0.103 mm dia.)) |
| Max.: | 10.643 mL/min (with 50/60 mL syringe (26.7 mm dia.)) |
| Linear Force : | 50 lbs (peak) |
| Drive: | |
| Motor: | 0.9∞ Stepper |
| Control: | Constant Current Drive, 0.5A per phase Full, 1/2, 1/4, 1/8 stepping |
| Drive Ratio: | 3.2:1 |
| Lead Screw Pitch: | 40 threads per inch |
| Encoder: | Optical, 32 line (for stall detection) |
| Step Rate: | |
| Min: | 3.8 sec/step |
| Max: | 840 µsec/step |
| Pusher Travel Rate: | |
| Min: | 0.002 mm/min |
| Max: | 17.8 mm/min |
| Display: | None |
| Keypad: | None |
| Interface: | RS-232 |
| Connectors: | RS-232/Power: 9-pin D-sub |
| Power: | +24VDC +/- 5%, 12 W max. |
| Dimensions: | 9.00 in x 5.00 in x 4.15 in (L x W x H) 22.9 cm x 12.7 cm x 10.5 cm |
| Mounting Dims: | 8.50 in x 4.3125 in (Mounting holes for (6) #6 screws) 21.6 cm x 11.0 cm |
| Ground Stud: | M5 |
| Weight: | 3.7 lbs (1.68 kg) |
| Environmental: | |
| Operating Temp: | +5 to +40∞ C (natural convection cooling) |
| Humidity: | 20% to 80% RH non-condensing |
| Storage Temp: | -30 to +45∞ C |
| Humidity: | 10% to 90% RH non-condensing |
| Pollution Degree: | Class I |
| Compliance: | Lead Free, RoHS Compliant |

RS-232 / Power Connector Pin-Out

P1-1: Ground
P1-2: RUN/STOP Input (Active Low)
P1-3: External Enable Input (Active Low)
P1-4: Running Output (Low = RUN, High = STOP)
P1-5: 24 Volts DC Positive
P1-6: RS232 Ground
P1-7: RS232 RXD
P1-8: RS232 TXD
P1-9: 24 Volts DC Return

The pump is set to the following default parameters on power-up and after an external enable command.

Default Settings

Syringe Diameter: 2.300 mm
Rate: 3.000 $\mu\text{l}/\text{min}$
Range: $\mu\text{l}/\text{min}$
Baud Rate: 9600

I/O Specifications:

Inputs:

RUN/STOP

This is an active low, TTL level input, pulled up to +5V through a 10K ohm resistor. It is ESD protected through a TVS device and filtered with a 0.1 μF capacitor to ground. Each pulse to a logic low toggles the pump between the RUN and STOP states.

EXT_ENABL/

This is an active low, TTL level input, pulled up to +5V through a 10K ohm resistor. It is ESD protected through a TVS device and filtered with a 0.1 μF capacitor to ground. A transition from logic high to logic low causes the processor to reset to its default state and enables the motor drive. A transition from logic low to logic high disables the motor drive through hardware (independent of firmware).

Outputs:

RUN_IND/

This is an active low output driven by two 74HCT14 inverters in parallel. An on-board resistor may be placed in series with this output to provide current limiting. The default resistor value is zero ohms. A logic low indicates RUN. A logic high indicates STOP.

Indicators:

Power-on LED

When illuminated, indicates that board is powered on and +5VDC supply is operating.

RUN LED

When illuminated, indicates that pump is running. When extinguished, indicates pump is stopped.

Appendix B: Syringe Inside Diameter

| | | | | | |
|---|-----------------|---|-----------------|---|-----------------|
| <i>Stainless Steel</i> | | <i>Terumo</i> | | <i>SGE Scientific Glass Engineering</i> | |
| <u>Size</u> | <u>Diameter</u> | <u>Size</u> | <u>Diameter</u> | <u>Size</u> | <u>Diameter</u> |
| 8 cc | 9.525 mm | 3 cc | 8.95 mm | 25 µl | 0.73 mm |
| 20 | 19.130 | 5 | 13.00 | 50 | 1.03 |
| 50 | 28.600 | 10 | 15.80 | 100 | 1.46 |
| <i>Becton Dickinson Plastic 'Plasti-pak'</i> | | 20 | 20.15 | 250 | 2.30 |
| <u>Size</u> | <u>Diameter</u> | 30 | 23.10 | 500 | 3.26 |
| 1 cc | 4.78 mm | 60 | 29.10 | 1.0 ml | 4.61 mm |
| 3 | 8.66 | <i>Sherwood-Monoject Plastic</i> | | 2.5 | 7.28 |
| 5 | 12.06 | <u>Size</u> | <u>Diameter</u> | 5 | 10.30 |
| 10 | 14.50 | 1 cc | 4.65 mm | 10 | 14.57 |
| 20 | 19.13 | 3 | 8.94 | <i>Hamilton-Microliter Series Gastight</i> | |
| 30 | 21.70 | 6 | 12.70 | <u>Size</u> | <u>Diameter</u> |
| 50/60 | 26.70 | 12 | 15.90 | 0.5 µl | 0.103 mm |
| <i>Air-Tite 'All Plastic'</i> | | 20 | 20.40 | 1 | 0.1457 |
| <u>Size</u> | <u>Diameter</u> | 35 | 23.80 | 2 | 0.206 |
| 2.5 cc | 9.60 mm | 60 | 26.60 | 5 | 0.3257 |
| 5 | 12.45 | <i>Popper & Sons, Inc. 'Perfektum' Glass</i> | | 10 | 0.460 |
| 10 | 15.90 | <u>Size</u> | <u>Diameter</u> | 25 | 0.729 |
| 20 | 20.05 | 0.25 cc | 3.45 mm | 50 | 1.031 |
| 30 | 22.50 | 0.5 | 3.45 | 100 | 1.46 |
| 50 | 29.00 | 1 | 4.50 | 250 | 2.3 |
| <i>Unimetrics Series 4000 & 5000</i> | | 2 | 8.92 | 500 | 3.26 |
| <u>Size</u> | <u>Diameter</u> | 3 | 8.99 | 1.0 ml | 4.61 mm |
| 10 µl | 0.460 mm | 5 | 11.70 | 2.5 | 7.28 |
| 25 | 0.729 | 10 | 14.70 | 5 | 10.3 |
| 50 | 1.031 | 20 | 19.58 | 10 | 14.57 |
| 100 | 1.460 | 30 | 22.70 | 25 | 23.0 |
| 250 | 2.300 | 50 | 29.00 | 50 | 32.6 |
| 500 | 3.260 | | | | |
| 1000 | 4.610 | | | | |

Appendix C: Flow Rates

| Nominal Syringe Size | Nominal Diameter (mm) | μl/hr | | μl/min | | ml/hr | | ml/min | |
|----------------------------|-----------------------------|--------|----------|--------|----------|-------|----------|--------|--------|
| | | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. |
| 0.5 μl | 0.103 | 0.001 | 17.715 | 0.001 | 0.295 | 0.001 | 0.017 | 0.000 | 0.000 |
| 1 μl | 0.150 | 0.002 | 37.571 | 0.001 | 0.626 | 0.001 | 0.037 | 0.000 | 0.000 |
| 2 μl | 0.210 | 0.003 | 73.639 | 0.001 | 1.227 | 0.001 | 0.073 | 0.001 | 0.001 |
| 5 μl | 0.330 | 0.006 | 181.845 | 0.001 | 3.030 | 0.001 | 0.181 | 0.001 | 0.003 |
| 10 μl | 0.460 | 0.010 | 353.337 | 0.001 | 5.888 | 0.001 | 0.353 | 0.001 | 0.005 |
| 25 μl | 0.730 | 0.025 | 889.855 | 0.001 | 14.830 | 0.001 | 0.889 | 0.001 | 0.014 |
| 50 μl | 1.030 | 0.049 | 1771.527 | 0.001 | 29.525 | 0.001 | 1.771 | 0.001 | 0.029 |
| 100 μl | 1.460 | 0.099 | 1999.999 | 0.002 | 59.323 | 0.001 | 3.559 | 0.001 | 0.059 |
| 250 μl | 2.300 | 0.245 | 1999.999 | 0.005 | 147.223 | 0.001 | 8.833 | 0.001 | 0.147 |
| 500 μl | 3.260 | 0.491 | 1999.999 | 0.009 | 295.772 | 0.001 | 17.746 | 0.001 | 0.295 |
| 1 ml | 4.610 | 0.981 | 1999.999 | 0.017 | 591.458 | 0.001 | 35.487 | 0.001 | 0.591 |
| 2.5 ml | 7.280 | 2.446 | 1999.999 | 0.041 | 1474.976 | 0.003 | 88.498 | 0.001 | 1.474 |
| 3 ml | 8.660 | 3.461 | 1999.999 | 0.058 | 1999.999 | 0.004 | 125.230 | 0.001 | 2.087 |
| 5 ml | 10.300 | 4.895 | 1999.999 | 0.082 | 1999.999 | 0.005 | 177.152 | 0.001 | 2.952 |
| 10 ml | 14.570 | 9.795 | 1999.999 | 0.164 | 1999.999 | 0.010 | 354.480 | 0.001 | 5.908 |
| 20 ml | 20.050 | 18.548 | 1999.999 | 0.310 | 1999.999 | 0.019 | 671.277 | 0.001 | 11.187 |
| 30 ml | 23.100 | 24.621 | 1999.999 | 0.411 | 1999.999 | 0.025 | 891.040 | 0.001 | 14.850 |
| 50 ml | 26.700 | 32.893 | 1999.999 | 0.549 | 1999.999 | 0.033 | 1190.408 | 0.001 | 19.840 |

Commands, Queries and Responses

After each transmission to the pump terminating with a CR character (ASCII 13), the pump enters remote mode and responds with the character sequence:

CR LF *prompt*

The prompt characters indicate the status of the pump as follows:

| prompt | meaning | ASCII code |
|--------|----------------------------|---------------------------------------|
| : | Stopped | (ASCII 58 decimal) |
| > | Running forward | (ASCII 62 decimal) |
| < | Running reverse | (ASCII 60 decimal) |
| * | Stalled | (ASCII 42 decimal) |
| *L | Limit switch actuated | (ASCII 42 decimal + ASCII 76 decimal) |
| *D | Disabled by emergency stop | (ASCII 42 decimal + ASCII 68 decimal) |
| *T | Target volume reached | (ASCII 42 decimal + ASCII 84 decimal) |

Serial Commands and Their Meanings:

Commands:

| | |
|------------|---|
| RUN | Start infuse (forward direction) |
| STP | Stop motor |
| CLV | Clears volume accumulator to zero |
| CLT | Clears target volume to zero, dispense disabled |
| REV | Reverses pumping direction |

Commands with Numbers:

| | | |
|------------|--------|---|
| MMD | number | Set syringe diameter, units are mm. Rate is set to zero after MMD command. |
| ULM | number | Set flow rate and range, units are microliters per minute |
| MLM | number | Set flow rate and range, units are milliliters per minute |
| ULH | number | Set flow rate and range, units are microliters per hour |
| MLH | number | Set flow rate and range, units are milliliters per hour |
| MLT | number | Set target infusion volume, units are ml or µl depending on range |

Numbers can be between 0 and 1999.

Leading zeros and trailing decimal point are optional. Any number of digits to the right of the decimal point may be transmitted. The number will be rounded.

Appendix D: Serial Communication

Queries:

- DIA** Returns diameter value units in mm
- RAT** Returns rate value set in current range units
- VOL** Returns current accumulated infused volume, units in ml or μ l depending on range
- VER** Returns model and version number of firmware
- TAR** Returns target volume, units in ml or μ l depending on range

value format: nnnn.nnn

The returned value is an 8 character string with leading zeros converted to SP characters (ASCII 32 decimal). The fifth character is a decimal point (ASCII 46 decimal).

Queries with String Response:

- RNG** Returns range message (character string either: ML/H ML/M UL/H UL/M)
- LIM** Returns limit switch status (True/False); True = limit switch actuated
- EMG** Returns emergency stop input status (True/False); True = Emergency Stop

Error Responses:

- CR LF ? CR LF prompt** Unrecognized command
- CR LF OOR CR LF prompt** Entered value is out of range

Declaration of Conformity

In accordance with ISO/IEC Guide 22 and EN 45014

Application of Council Directive: 73/23/EEC
89/336/EEC

Standard(s) to which
conformity is declared:

Safety:

EN 61010-1, 2nd Edition (2001)

IEC 61010-2-081

Emissions/Immunity:

IEC 61326:1997 w/ A1:1998 & A2:2001

IEC 61000-4-2:1995

IEC 61000-4-3:1996

IEC 61000-4-4:1995

IEC 61000-4-5:1995

IEC 61000-4-6:1996

IEC 61000-4-11:1994

IEC 61000-3-2:2001 w/ Am.14

IEC 61000-3-3:1995 + Corr. 1997

Manufacturer's Name:

Harvard Apparatus, Inc.

Manufacturer's Address:

*84 October Hill Road
Holliston, Massachusetts 01746
U.S.A.*

Type of Equipment:

Caribou OEM Syringe Pump

Model No.:

98-2482

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

EMC and Safety compliance were evaluated by Intertek/ETL Semko

Reference test report file numbers: 310496 and 3103711

Place:

United States of America

Date:

June 28, 2007



HARVARD

A P P A R A T U S


(Signature)

Beth Bauman

(Full Name)

VP Engineering/ Operations

(Position)